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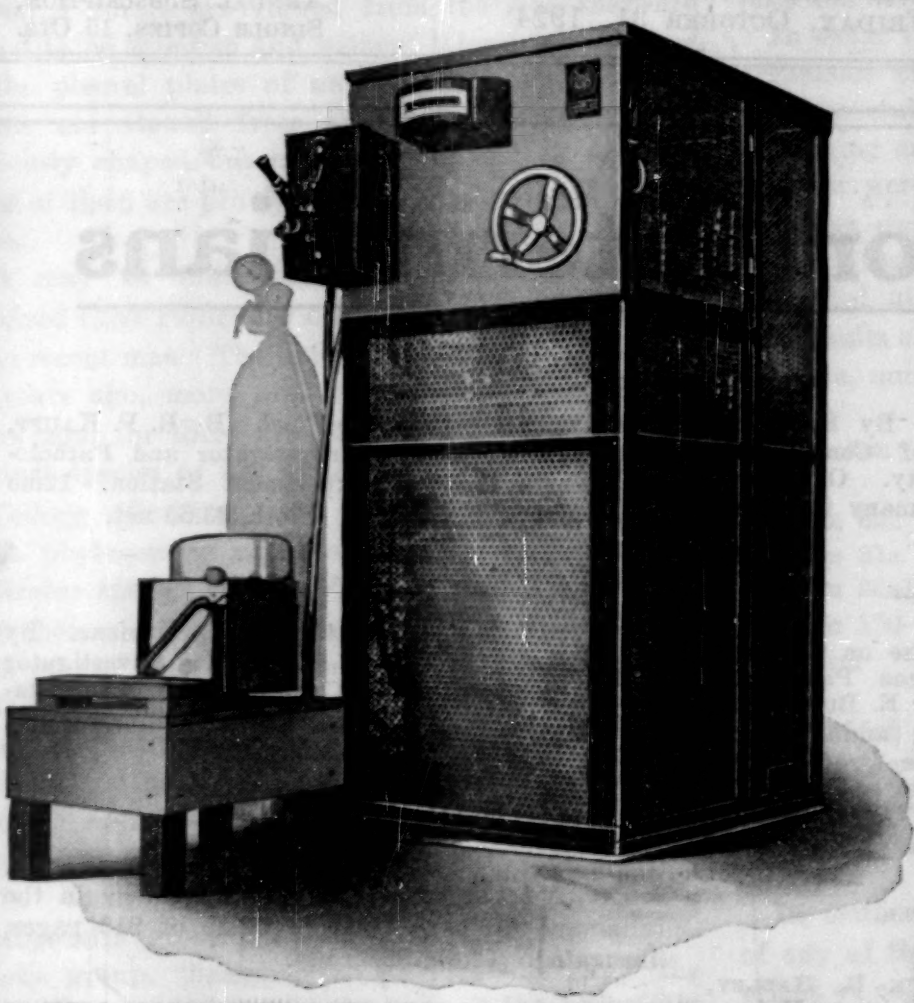

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PRELIMINARY MEASUREMENT OF THE VELOCITY OF LIGHT[1]

THE velocity of light is one of the most fundamental of the constants of nature, and this alone would justify the attempt to measure its value with the highest possible precision. But in addition to its scientific importance it may prove to have a practical value if the result of such a measurement can be obtained with sufficient accuracy.

The mean of the various measurements thus far attempted is 186,330 miles per second, with an uncertainty of 20 or 30 miles. If this uncertainty can be reduced to one mile, the result could be utilized to obtain distances between stations from 50 to 100 miles apart far more expeditiously and with an order of accuracy at least as great as that obtainable by the usual method of triangulation. Indeed, there are possibilities of utilizing the velocity of light in cases where triangulation would be difficult or impossible.

An invitation tendered by Dr. G. E. Hale, then director of the Mt. Wilson Observatory, and supported by Dr. J. C. Merriam, director of the Carnegie Institution, made it possible to install the necessary apparatus on Mt. Wilson, with Mt. San Antonio 22 miles away as the distant station, during the summer of 1923; but smoke and haze from burning oil and from forest fires made it impossible even to test the feasibility of the method at so great a distance.

This was accomplished during the past summer with very promising results. The set-up of apparatus involved several important changes in the arrangement employed in previous investigations, the most important of these consisting in the substitution of an octagonal revolving mirror instead of a plane-parallel, together with a system of reflectors which eliminated all direct and diffuse extraneous light. Finally, a simple method for returning the light from the distant station back to the source was substituted for the plane mirror used for this purpose in previous work, and this functioned so well that no readjustment was required during the entire two months of the work.

The advantage of the octagonal revolving mirror, in addition to the higher speed obtainable, lies in the possibility of receiving the return light on a succeeding face, thus eliminating the measurement of the angular deflection of the returned beam; or rather

[1] Presented at the Centenary Celebration of the Franklin Institute, Philadelphia, September 17–19, 1924.

transferring this measurement to the construction of the octagon, the angles of which were tested and found to be equal with an uncertainty of only one part in a million.

The determination of the velocity of light is thus reduced to the measurement of the distance between the stations and of the speed of rotation of the mirror. The former operation was carried out by the U. S. Coast and Geodetic Survey with the result 35,426.3 meters (about 22 miles) with an uncertainty of the order only two parts in a million.

The errors in the measurement of the speed of the revolving mirror were much greater, as no very effective means were employed to insure its constancy. (This defect will be eliminated in the continuation of the work next summer.)

Notwithstanding the inconstancy of the speed of the mirror, by choosing the most favorable moment, when the speed was that corresponding to the frequency of a control tuning fork, the resulting uncertainty of the measurements was of the order of one ten thousandth part, which is about that of the mean of all the previous measurements.

It is hoped that next year's work will furnish results four or five times more accurate.

The result of eight independent observations in the present preliminary work is, for the velocity of light in vacuo, 299,820 kilometers per second.

Following is a table of results of the more important investigations to date with an estimate of the weight which should be assigned to each:

Investigator	Method	Distance	Wt.	Velocity
Cornu	Toothed Wheel	23.0 Kilom.	1	299950
Perrotin	" "	12.0 "	1	299900
Michelson	Revolving Mirror	0.6 "	2	299895
Newcomb	" "	6.5 "	3	299860
Michelson	" "	35.4 "	3	299820

A. A. MICHELSON

UNIVERSITY OF CHICAGO

A NEW TYPE OF ELECTRIC DISCHARGE: THE STREAMER DISCHARGE[1]

IN connection with a detailed study of the mechanism of electric discharges in argon we have observed some phenomena of remarkable beauty which may prove to be of theoretical interest.

A single loop tungsten filament of large diameter (0.5 mm) is mounted at one end of a cylindrical pyrex glass bulb 10 cm in diameter and 15 cm long with its axis horizontal. Rising vertically from this bulb is a tube 3 cm in diameter and 50 cm long which contains at its upper end a disk shaped anode. The tube is exhausted for an hour at 450° C., and the electrodes are freed from gas by induction heating and the tube is filled with extremely pure argon at a pressure of preferably 2 to 4 mm of Hg. The cathode is heated to about 2500° K and + 250 volts is applied to the anode through a resistance. By approaching one terminal of a high frequency coil to the middle of the glass tube an arc of about one ampere is started through the tube, and the voltage difference between anode and cathode falls to about 25 volts.

The arc then fills the tube with a uniform pale reddish glow showing only lines of the red argon spectrum. A transverse magnetic field, from a hand horseshoe magnet with poles 4 cm apart, has practically no effect on the appearance of the arc.

The *streamer discharge* may now be started by opening the cathode heating circuit for *one half second,* allowing the current to return immediately to its former value. This lowers the cathode temperature momentarily and by decreasing the electron emission causes the voltage across the arc to rise from 25 to 100 volts or more for perhaps a second. The cathode drop sputters tungsten from the cathode in an amount which is estimated to lie between 10^{-6} and 10^{-7} grams.

This small dose of tungsten vapor has a profound effect on the arc. There are at first brilliant blue flashes of light from the lower end of the tube which show the tungsten spark spectrum. Simultaneously the arc begins to detach itself from the glass walls, starting at the lower end and gradually, in 5 to 15 seconds, extending up to the anode.

After 30 seconds or so the blue tungsten spectrum disappears and the arc quiets down but remains detached from the walls for its entire length. At first the arc is 1 to 1.5 cm in diameter and is bounded by a sharply defined luminous skin which emits a dull yellow light showing a continuous spectrum. The interior of the arc is reddish (argon spectrum), but is separated from the yellow skin by a dark space 1 or 2 mm thick.

Sometimes just inside this dark region there is a transient bluish white skin of considerable brilliancy which seems to show a mixture of continuous spectrum with the tungsten spectrum.

After perhaps 1 minute the yellow skin has disappeared and the arc has increased so much in cross-section that it seems at first as if it had returned to its original condition.

[1] Abstract of an address by Irving Langmuir at the Centenary of the Franklin Institute, Philadelphia, September 18, 1924.

The arc, however, is now very sensitive to even weak magnetic fields. On bringing the horseshoe magnet within 10 to 15 cm of the tube, so as to produce a transverse field, the arc is deflected to one side of the tube in the same direction as any conductor carrying a similar current. Thus the arc is pushed up against the wall of the tube and at the same time the *yellow skin* reappears on the opposite side of the arc, that is on the side which is not in contact with the wall of the tube.

Upon bringing the magnet still closer the yellow skin becomes more brilliant and thinner, and then begins in a remarkable way to exhibit many of the characteristics of a liquid surface. In fact the appearance is strikingly similar to that of the surface of water dripping from the under side of a horizontal wet board. Little droplets of golden yellow liquid fire form slowly, move irregularly parallel to the direction of the surface and then break away and fall, as little spheres of light, in a direction perpendicular to the surface (into the arc). By regulating the intensity of the magnetic field these droplets, or globules, ranging from a few tenths mm up to 5 or 6 mm in diameter, can be made to form slowly and detach themselves singly from the skin of the arc. They usually move all the way across the arc and disappear when they reach the opposite boundary close to the glass wall. But by proper combinations of longitudinal and transverse field the globules may often be made to move upwards or downwards in the arc parallel to its axis for distances of 5–10 cm. The light emitted by the globules is nearly white and is enormously more brilliant than that from the yellow skin of the arc.

Under certain conditions the globules have been observed to move very slowly so that their motions through the arc could be easily followed by the unaided eye. But more often they move at velocities of 10 to 30 cm per second and thus appear as brilliant lines or filamentary streamers. As the field is increased the individual globules follow in such rapid succession along a single path that the streamers appear to be continuously visible. With stronger fields several streamers with nearly parallel paths are observed and then as the number of such streamers increases they join to form beautifully curved luminous surfaces. Finally by the multiplication of such surfaces there may appear to be certain regions which have a luminosity distributed throughout a volume.

By superimposing an alternating component on the direct current fed to the anode, or by heating the cathode by alternating current, the streamers or individual globules move in sinusoidal paths which reproduce accurately the wave shape of the current even at frequencies up to 1,000 cycles. Sometimes the arc-discharge itself oscillates at frequencies in the neighborhood of 1,000 cycles and the globules then increase and decrease periodically in brilliancy so that the streamer due to a single globule appears beaded.

By "stroking" the tube up or down with the magnet, the tungsten responsible for the streamer discharge can be concentrated at will at the upper or lower end of the tube.

All these effects persist for hours as long as the arc current is maintained at about one ampere without any necessity for replenishing the supply of tungsten vapor.

If the arc current is stopped for 5 seconds and restarted without lowering the filament temperature, the streamer discharge phenomena persist with only a moderate decrease in intensity. But if the arc is allowed to remain out for as much as 40 seconds practically all the effects due to tungsten vapor disappear. To restart the streamer discharge more tungsten must be introduced by sputtering tungsten from the cathode or from an auxiliary electrode at high negative potential or by vaporizing tungsten from a filament at temperatures of 3000° K or more.

Similar effects can be obtained by sputtering molybdenum, tantalum or carbon into the arc, but the phenomena seem to be more striking and more persistent with tungsten.

By focusing a concentrated beam of sunlight into the tube containing a streamer discharge the yellow skin of the arc (or with weak excitation a region just outside the yellow skin) scatters light which appears to be completely polarized when observed at right angles to the incident light. By this method the skin of the arc in presence of a magnetic field can be seen to extend far beyond the luminous yellow skin. In the presence of the field there is some light scattered from the whole of the non-luminous gas outside the arc, but the intensity increases rapidly as the skin is approached. No scattered light is detected from the interior of the arc except from the streamers or globules that pass through it and these give very intense scattering.

When a short constriction is placed at a point in the tube carrying the arc and particularly when the tungsten has been concentrated in this constriction by stroking by a magnet, a brilliant light (continuous spectrum) is emitted from a thin skin which remains within a fraction of a mm of the wall even after the magnetic field is removed.

A fairly complete explanation of these phenomena together with quantitative data for testing the theory will be published in the *Journal* of the Franklin Institute. The following is a brief outline of the theory.

The walls of the tube are negatively charged and the tungsten atoms and particles in the region outside the arc also become negatively charged and thus can not deposit on the walls. In the arc there is a high concentration of free electrons moving in random directions while outside the arc the concentration is low. Thus, according to the Boltzman equation (or the Nernst electro-chemical equation), there must be a potential difference between the interior of the arc and the surrounding space (the arc being positive). The potential distribution must therefore be such that the potential gradient is zero at the axis of the arc, increases to a maximum near the skin of the arc and again becomes small near the walls. Thus from Poisson's equation near the boundary of the arc there must be an electric double layer consisting of an inner sheath having a positive space charge and an outer sheath with a negative charge.

Such a double layer in a gas can only be maintained if the positive ions which continually escape through the positive sheath disappear by recombination at the inner edge of the negative sheath. The presence of particles (or ions) which can take up negative charges will not only bring about such recombinations but will aid in the formation of the negative space charge. At the boundary between the positive and negative sheaths negative tungsten ions lose their charge and in the neutral state no longer repel one another. They can thus condense on one another to form minute solid particles.

The effect of the magnetic field is solely to produce convection currents in the argon due to the non-uniform distribution of current throughout the cross-section. The convection currents cause the arc to be carried to one side of the tube and cause the non-luminous gas carrying negatively charged tungsten ions and particles to flow into the arc on the side away from the wall. At the junction between the negative and positive sheaths all the negative ions and larger particles lose their charges and become either neutral or positive. The neutral atoms and particles then no longer repel one another and thus grow to larger aggregates. As these are carried into the positive sheath they are heated by the energy set free by the recombination of positive argon atoms and electrons and are ultimately disintegrated or evaporated by this positive ion bombardment. The resulting tungsten atoms become positively charged within the positive sheath, and migrate under the influence of the electric field in the opposite direction to that of the convection current. The tungsten thus accumulates at the boundary between the positive and negative sheaths in the form of minute solid particles or aggregates. If any transverse motion causes more rapid concentration at some places than others the increased recombination at these places makes the sheaths more sharply defined and still further increases the rate of accumulation of tungsten. When sufficient tungsten is present at any place to cause practically complete recombination of the positive ions, the skin projects into the arc and then because the direction of migration of the particles in the electric field becomes nearly perpendicular to the direction of the convection currents, the skin forms a kind of funnel from the narrow end of which the globules break away and are carried at the velocity of the convection currents into the body of the arc.

The structure of a detached globule is thus essentially similar to that of the detached arc itself except that it is turned inside out, as can be readily understood from its mode of function.

Thus we must conclude that the inside of a detached globule is negatively charged and that this is surrounded by a positive ion sheath. The tungsten is imprisoned inside the globule in the form of solid particles which are concentrated particularly at the boundary of the regions of positive and negative charge.

The recombination of ions furnishes the energy for the heating of the particles and the maintenance of the electric fields.

These glowing detached globules seem to have characteristics similar in many respects to those that have been described as belonging to ball lightning. It is perhaps not certain that ball lightning is anything more than a psychological phenomenon, but if it has objective reality it may possibly be due to causes similar to those outlined above: the presence of highly ionized gas, recombination of ions on catalytically acting solid particles which are held within the ball by their charges and the electric field at the surface of the ball.

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THE RACIAL ORIGIN OF ALMSHOUSE PAUPERS IN THE UNITED STATES[1]

DURING and since the war our lawgivers seem to have been more concerned about the racial heterogeneity of the American people than for many years before. Under expert eugenic advice a new immigration law has recently been passed by congress, care-

[1] Papers from the Department of Biometry and Vital Statistics, School of Hygiene and Public Health, The Johns Hopkins University, No. 110.

fully calculated, so that body and the public were told, to make relatively easy the coming of "desirable" racial elements, and relatively difficult the entrance of "undesirable" racial elements. The soundness of the foundations of the expert eugenic advice has been somewhat called in question by Jennings, Buchholz and various other persons who have taken the trouble to look into the evidence which was presented to congress, and which apparently, in some degree at least, influenced that body's action. But in any event the deed is done, and is widely hailed as a triumph of eugenics. Even with this political *fait accompli*, however, data on any aspect of race in the United States are always welcome.

These considerations, and some others, lead me to call attention here to some statistics very recently issued by the Bureau of the Census in an eight-page pamphlet entitled "Paupers in Almshouses: 1923." "These statistics relate only to inmates of public almshouses and do not include inmates of any other institutions or recipients of outdoor relief." In spite of this limitation the figures presented have a good deal of significance. I shall discuss here only one of the many interesting points which the figures raise, namely, the racial background of our public almshouse pauperism.

It appears that there were enumerated on January 1, 1923, 72,336 white paupers in almshouses, and 5,511 negro paupers in the same situation, these figures being, respectively, 92.6 and 7.1 per cent., or together 99.7 per cent. of all the paupers in almshouses at that date. Inasmuch as at the census of 1920 the negroes constituted 9.9 per cent. of the total population of the country, it appears that the negro certainly made no worse showing in respect of almshouse pauperism than the white, and in fact a somewhat though not greatly better one. The same thing was true in 1910. The decrease in the proportion of almshouse paupers to the total population between 1910 and 1923 was more marked in the case of negroes than in native whites, with which group of whites the negroes may most properly be compared; for while the number of native white almshouse paupers decreased from 65.0 per 100,000 of the same class of the population in 1910 to 59.8 in 1923 (5.2 points), the number of negroes in the same situation decreased from 63.9 per 100,000 of the same class of the population to 52.7 (11.2 points). Keeping in mind always the cautionary fact that these figures relate to paupers in public almshouses only, it would appear that any social indictment of the negro race, as a race, in respect of pauperism would probably be difficult to maintain.

Turning now to the whites, it appears that of the 72,336 in almshouses on January 1, 1923, 48,019, or 66.4 per cent., were native-born; 23,557, or 32.6 per cent., were foreign-born, and 760, or 1.0 per cent., were of unknown nativity. The corresponding percentages on January 1, 1910, were: For native-born 56.9 per cent., for foreign-born 42.6 per cent. and for persons of unknown nativity 0.5 per cent. These facts would appear to suggest that during the period covered a change has come about, which has had as its result a distinct diminution in the proportion of foreign-born to total white almshouse paupers. The available data furnish no means of determining the nature of the social forces which have produced this change. The fact, however, is interesting. It means that we were paying for the care of nearly 10,000 *fewer* foreign-born white persons in almshouses in 1923 than in 1910, while at the same time we were paying for nearly 4,000 *more* native-born white persons in 1923 than in 1910. Such meager comfort as is, insofar, derivable from this whole unfortunate situation plainly appears to be offered by the foreign-born and not the native-born.

But there is another statistical angle to the case which must not be overlooked, particularly as it is almost the only one that is commonly presented. While on January 1, 1923, there were in almshouses 59.8 native-born white persons per 100,000 of the same class in the population, the corresponding figure for the foreign-born was 173.6. This is by some regarded as a fact of dread significance. Perhaps it is. To me it seems possibly only an interesting expression of the difficulties which the human organism finds in adapting itself to a new environment. A high pauperism rate of foreign-born can, of course, be eliminated by so arranging matters that there are no foreign-born in the population. But in any circumstances which permit foreign-born persons to settle in this country, it seems probable that their pauperism rate will be higher than that of natives. Furthermore, the mental discomfort engendered by the higher foreign-born *rate* of pauperism would seem to be in some degree mitigated by the fact, already brought out, that we are, on the evidence, paying for the upkeep of a *decreasing absolute* number of foreign-born paupers in almshouses all the time. It is absolute mouths that it costs money to feed. High *rates* may be relatively inexpensive things.

Further light on this phase of the matter is afforded by the figures:

	Paupers in almshouses, enumerated on stated date, per 100,000 of the same class of the population	
	Jan. 1, 1910	Jan. 1, 1923
Native white	65.0	59.8
Foreign-born white	249.3	173.6

The decrease in the period is definitely more marked in the case of the foreign than in that of the native-born. This is made clear in Fig. 1, which is a ratio

TABLE I

COUNTRY OF BIRTH OF FOREIGN-BORN WHITE PAUPERS IN ALMSHOUSES, 1923

Country of birth	Foreign-born white paupers in almshouses		Per cent. distribution of foreign-born population of U. S., 1920	Difference between first and third columns
	Enumerated Jan. 1, 1923	Admitted during 1922		
	Per cent. distribution	Per cent. distribution		
All countries	100.0	100.0	100.0	
Northwestern Europe:				
England	8.0	7.2	5.9	+ 2.1
Scotland	2.6	2.5	1.9	+ 0.7
Wales	0.9	0.7	0.5	+ 0.4
Ireland	26.2	24.0	7.6	+18.6
Norway	2.0	1.5	2.7	— 0.7
Sweden	5.0	3.8	4.6	+ 0.4
Denmark	1.3	1.0	1.4	— 0.1
Netherlands	0.7	0.6	1.0	— 0.3
Belgium and Luxemburg	0.5	0.4	0.5	0.0
Switzerland	1.6	1.2	0.9	+ 0.7
France	1.5	1.2	1.1	+ 0.4
Central Europe:				
Germany	20.8	13.7	12.3	+ 8.5
Poland	4.4	6.4	8.3	— 3.9
Czechoslovakia	2.8	3.2	2.6	+ 0.2
Austria	1.9	2.7	4.2	— 2.3
Hungary	1.4	1.9	2.9	— 1.5
Jugo-Slavia	0.5	0.7	1.2	— 0.7
Southern and Eastern Europe:				
Russia	2.2	3.9	10.2	— 8.0
Lithuania	0.7	0.9	1.0	— 0.3
Finland	1.0	1.3	1.1	— 0.1
Greece	0.3	0.9	1.3	— 1.0
Italy	3.1	5.4	11.7	— 8.6
All other	0.6	1.4	1.8	— 1.2
America:				
Canada—French	2.5	2.9	2.2	+ 0.3
Canada—Other and Newfoundland	5.5	5.8	6.0	— 0.5
Mexico	0.8	2.7	3.5	— 2.7
All other	0.1	0.2	0.3	— 0.2
All other countries and unknown	1.2	1.8	1.3	— 0.1

chart on an arithlog grid, used to make the slopes of lines visually comparable.

The admissions during the year show the same thing as the enumerations. I have added the lines for admissions in Fig. 1, but will not take the space to give the figures.

Let us turn now to the consideration of the data which are the most interesting of all from the standpoint of human biology, namely, the figures which show the country of birth of the foreign-born white paupers in almshouses in 1923. Table I presents the essential material.

The figures in the last column of Table I are exhibited graphically in Fig. 2.

The table and diagram require little comment. With a few trifling exceptions, all the countries from which the present law *encourages* immigration contributed to almshouse pauperism in 1923 in *excess* of their representation in the population in 1920. On the other hand, again with a few trifling exceptions, those countries from which the present immigration law was especially framed to *discourage* immigration appear in the lower part of the diagram, because they contribute a *smaller* proportion to almshouse pauper-

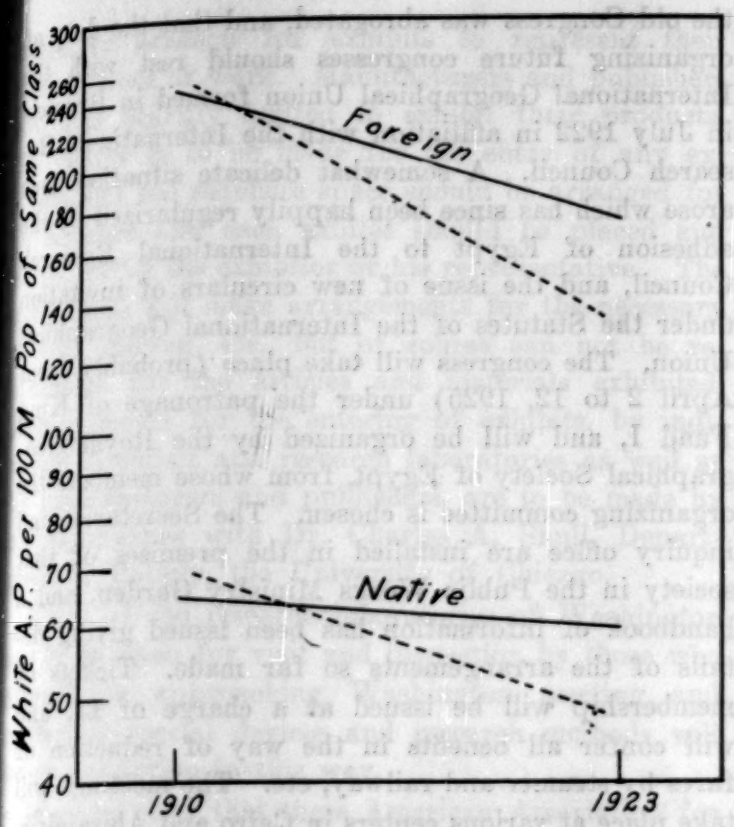

FIG. 1. Ratio chart showing decrease in proportion of almshouse paupers to the total population from 1910 to 1923. Solid lines, enumerated on January 1 of year; broken lines, paupers admitted to almshouse during years 1910 and 1922.

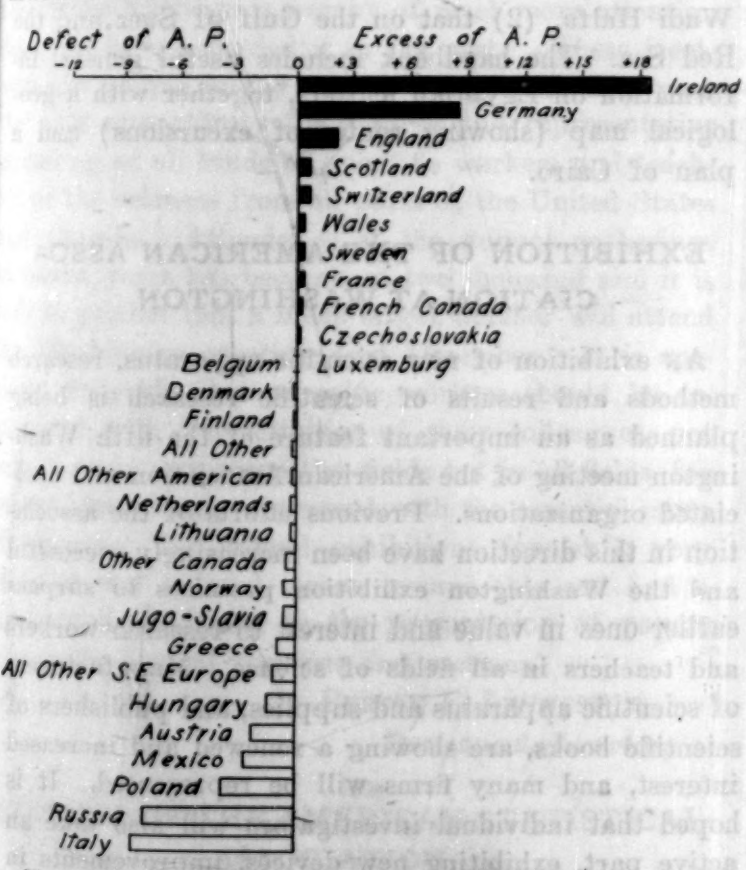

FIG. 2. Showing the excess (black bars) or defect (white bars) of the percentage presentation of different racial groups in public almshouses, as compared with their representation in the general population.

ism in 1923 than their representation in the general population in 1920. Immigration from five countries in particular, Austria, Mexico, Poland, Russia and Italy, has been subjected to much criticism. It is interesting to note that the immigrants from each of these five countries contributed proportionately *less* to our almshouse pauperism in 1923 than any other group of foreign-born people in the country.

RAYMOND PEARL
THE JOHNS HOPKINS UNIVERSITY

ROMEYN BECK HOUGH—1857–1924

WHEN an official or one connected with an outstanding educational institution ceases his scientific work, the fact is noted usually and his life effort is appraised. When, as an amateur, he has rendered comparable service to science, this is more likely to be overlooked.

Romeyn Hough is one whose contributions to a knowledge of North American trees ought not to be overlooked because his name may be sought in vain year after year in the bibliographic records of dendrology. He may never have appended his name to a specific binomial or a varietal trinomial. He may never have expressed in print curiosity even as to why some people put dogwood and peperidge into one family, while others consider them representative of two families. But, accepting the taxonomic and nomenclatorial views of those whom he felt disposed to consider authoritative on these vexed questions, he did very much to make it easier for people to become acquainted personally with our trees.

His interest in nature was not artificially implanted and skilfully nourished; it was inherited. Forestry as a national interest took form under his father, Franklin B. Hough. To father and son natural history was a matter of out-of-doors; the real thing appealed to them rather than its presentment. Before Romeyn entered college he knew a great deal of nature—the kind of nature-lore that few have and still fewer teach now-a-days. One of the privileges of my early years at Cornell was to get afield with him. Only last fall we recalled a never-to-be-forgotten example of mother love that a flying squirrel showed us nearly fifty years ago.

Hough never became a teacher: perhaps he was not drawn to the routine of pointing out to others what he found pleasure in seeking out for himself. He qualified as a physician, like his father; but he really became in a sense a manufacturer and publisher, combining avocation with vocation, for he manufactured structural sections—macroscopic and microscopic—of the trees that he knew so well.

Many years ago, Nordlinger issued a series of small thin cross-sections of German and exotic woods. I think that eleven centuries of these were issued. A

few other scarcely notable series of the same kind have been published. Hough conceived the idea of issuing our native woods in larger sections, representing side by side the three—cross, radial and tangential—needed for a stereo visualization of the stem structure. Thirteen fascicles, of twenty-five species each, have been published; and these auto-illustrations stand alone in their field. Mastering the technique of cutting such sections opened a commercial industry in cross-section business cards and the like, the use of which he promoted extensively.

Monographs and manuals of North American trees are many and varied; unique among them is Hough's "Handbook of the Trees of the Northern United States and Canada," with its admirably selected and prepared phototype and distribution map and a photographic reproduction of the cross-section of the wood of each species.

It is to be regretted that their author did not live to bring out two contemplated additional fascicles of the sections of American woods, and a "Handbook of Western Trees" that he planned as a companion to the eastern volume; but there is reason to hope that the materials for both are sufficiently in hand to insure their publication. Whether this be so or not, however, Romeyn B. Hough has made a rare contribution to American botany in a model book, and especially in a series of illustrations consisting of the woods themselves—which, unlike texts and drawings, never can become out-of-date nor be found to contain untruths except as the names applied in his day to the trees he sectioned undergo change with progressing knowledge.

WILLIAM TRELEASE

UNIVERSITY OF ILLINOIS

SCIENTIFIC EVENTS

THE INTERNATIONAL GEOGRAPHICAL CONGRESS[1]

THE project of an International Geographical Congress to be held at Cairo in 1925 was first discussed over two years ago in association with the coming jubilee of the foundation of the Sultanieh Geographical Society of Egypt. It soon developed into a plan for the revival of the old international congresses held in different countries before the war, being regarded by its promoters in Rome (where the tenth congress was held) as the eleventh of the series. Circulars of invitation were issued on this basis by a committee formed in Egypt, but it was pointed out that by the decision of the International Research Council, formed shortly after the end of the war, the constitution of the old Congress was abrogated, and that the duty of organizing future congresses should rest with the International Geographical Union formed in Brussels in July 1922 in affiliation with the International Research Council. A somewhat delicate situation thus arose which has since been happily regularized by the adhesion of Egypt to the International Research Council, and the issue of new circulars of invitation under the Statutes of the International Geographical Union. The congress will take place (probably from April 2 to 12, 1925) under the patronage of King Fuad I, and will be organized by the Royal Geographical Society of Egypt, from whose members the organizing committee is chosen. The Secretariat and inquiry office are installed in the premises of that society in the Public Works Ministry Garden, and a handbook of information has been issued giving details of the arrangements so far made. Tickets of membership will be issued at a charge of £1, and will confer all benefits in the way of reduction of fares by steamer and railway, etc. The meetings will take place at various centers in Cairo and Alexandria. A provisional program has been drawn up, covering the various principal branches of geography and their subdivisions, and a scheme of excursions arranged, the two principal being, (1) that from Cairo to Aswân or Wadi Halfa, (2) that on the Gulf of Suez and the Red Sea. The handbook includes useful general information on Egyptian matters, together with a geological map (showing routes of excursions) and a plan of Cairo.

[1] From *The Geographical Journal.*

EXHIBITION OF THE AMERICAN ASSOCIATION AT WASHINGTON

AN exhibition of new scientific apparatus, research methods and results of scientific research is being planned as an important feature of the fifth Washington meeting of the American Association and associated organizations. Previous efforts of the association in this direction have been increasingly successful and the Washington exhibition promises to surpass earlier ones in value and interest to research workers and teachers in all fields of science. Manufacturers of scientific apparatus and supplies, and publishers of scientific books, are showing a renewed and increased interest, and many firms will be represented. It is hoped that individual investigators will also take an active part, exhibiting new devices, improvements in apparatus and methods, specially fine preparations, etc., thus giving to the whole undertaking a personal element that will be greatly appreciated. Members of the association and members of associated organizations are cordially invited and urged to help in this way. Those in charge of research laboratories are

asked to arrange for exhibits to represent their various lines of work. Manufacturers and publishers are also heartily invited to exhibit their products. No charge is to be made for the entry of any exhibits, but the requisite space should be arranged for in advance and each exhibit should be placed and cared for by the exhibitor or his representative. The association will make arrangements for the necessary rooms, lighting, etc., but of course can not be responsible for the articles and materials exhibited. Arrangements for the entering of exhibits, by individual scientists and research laboratories as well as by manufacturers and publishers, are to be made by correspondence with Dr. Charles A. Shull, Department of Botany, the University of Chicago.

Many of the research laboratories of Washington are to be open for visit and inspection by those who attend the approaching Washington meeting and numerous special devices and research methods will be on exhibition in this way.

It seems clear that these American Association for the Advancement of Science exhibitions should become increasingly valuable as definite aids to the advancement of American science. Great progress has already been made, but this feature of the annual all-science meetings is worthy of much more attention than has been accorded it in the past. These meetings are unique in the fact that they offer each year the only opportunity for a large and representative gathering of all kinds of scientific workers and teachers of the sciences from all parts of the United States and Canada. Attendance at the annual gatherings in recent years has been about two thousand and it is safe to predict that a much larger number will attend the Washington meeting next December. It is specially desirable that scientific workers should be acquainted with the activities of their colleagues, not only in their own respective fields but in all fields, for we are increasingly impressed with the essential unity of science. The annual exhibitions furnish a very valuable and helpful means toward this end and a much needed adjunct to the presentation of papers before the several societies and sections.

BURTON E. LIVINGSTON,
Permanent Secretary

MEETING OF THE AMERICAN STATISTICAL ASSOCIATION

THE eighty-sixth annual meeting of the American Statistical Association will be held at Chicago on December 29 and 31. The experiment tried out last year of having the several sessions of the annual meeting deal with various phases of one general subject proved so successful that it has been decided to repeat the plan at the coming annual meeting of the association. The president, after consultation with other members of the association, has selected the topic "Population," and has developed a program on that theme. The subject is not only of great importance both theoretically and practically, but is one in which the statistician is in a strategic position to make a vital contribution to current political and economic thought. Moreover, it is a subject which bears directly upon the research activities of many of our members.

The subject of population is also arousing interest in allied scientific fields. For this reason it has been possible to arrange for joint sessions with the American Economic Association, and the American Association for Labor Legislation. With the economists we will discuss the connection between population and natural resources; with the labor legislation group the subject of population and the labor supply. In addition, we will develop independently three sessions, the first dealing with a statement of the problem and its various ramifications; the third dealing with the racial constitution of the population and the problem of immigration; and a final meeting in which we will discuss the outlook for the future, and the practical steps which should be taken in developing a rational public health, economic and social program.

As the subject is such a broad one and the time in which to cover it is so limited, the individual sessions are necessarily rather long and in some cases contain more papers than is altogether desirable. But it was necessary to arrange the program thus, in order to cover all angles of the subject and to round out every vital phase of the question. It is, therefore, impossible to appoint set persons to discuss each paper. But since many of our members are actively engaged in research work in this field, it should be possible to have a lively, even if it appear like an impromptu, discussion from the floor. There will be a reasonable length of time set aside expressly for such discussion and it is hoped that many of our members will show their interest by adding their contributions to the set papers which are scheduled.

Though the general outline of the program is fairly well settled, there is still time to make a few additions and changes and to this end suggestions and recommendations are earnestly requested. Information concerning original investigations now in process and the names of contributors who are doing valuable work on this subject should be sent to the president. Above all it is hoped that many members will attend and take an active part in the discussion. The success of the conference, as a whole, will depend upon the enthusiasm and whole-hearted support of each member.

LOUIS I. DUBLIN,
President

MUNSELL RESEARCH ASSISTANTSHIPS IN COLORIMETRY AT THE NATIONAL BUREAU OF STANDARDS

THE Munsell Research Laboratory has established two positions of research assistant in colorimetry to be stationed at the National Bureau of Standards, Washington, D. C.

The chief purpose of these assistantships is to provide for training interested and suitably qualified young men in the practice and technic as well as the theory of colorimetric measurements, in order that they may become eligible for higher positions of greater responsibility which it is expected will be open later to those who prove their competence for this kind of work.

These assistants will work in the section of colorimetry of the Bureau of Standards under the direction of Mr. Irwin G. Priest and Dr. K. S. Gibson. They will be in close contact with the work of the section, and will have unusual opportunities to learn by experience, observation and conference with other members of the staff. The work of this section includes spectrophotometry by various methods, colorimetry and research in visual psycho-physics. The chief duties of these positions will be to assist in research and testing involving the use of the spectrophotometer, the "monochromatic colorimeter" and various other photometric and colorimetric instruments used in testing and research. Opportunities for study will also be available.

Applicants must have the following qualifications for appointment:

(1) A *bona fide* desire and intention to specialize in this kind of research as a life work. (There is, of course, no contract or binding agreement on this point, but it is desired to make clear the condition that persons who have no interest except that of temporary employment while they are planning for some other field of work are not expected to apply for these positions.)

(2) A bachelor's degree or its approximate equivalent in previous education, including physics.

(3) Normal vision or only such refraction errors as are readily corrected.

(4) Normal color sense.

(5) Age limits: between 19 and 25 years.

Salaries will be between $1,600 and $2,500 per year. The exact amount will depend upon previous experience and education, and such recommendations as the applicant may submit; and will be fixed after conference with the applicant.

Appointments will be for a term of one year.

Applications for appointment or request for further information may be addressed to the Munsell Research Laboratory, 10 East Franklin St., Baltimore, Md.

NATIONAL RESEARCH FELLOWSHIPS IN THE MEDICAL SCIENCES

FOURTEEN fellows were appointed by the Medical Fellowship Board of the National Research Council on September 20, as follows:

Name	Place of Work	Subject
Miss E. B. Carrier, M.D., Johns Hopkins Hospital, Baltimore, Md.	Harvard Medical School	Physiology Anatomy
Benjamin Freeman, Ph.D., Columbia University, New York	Univ. of Pennsylvania	Physiology Pharmacology
M. S. Hollenberg, M.D., University of Manitoba, Winnipeg, Manitoba, Can.	Johns Hopkins Univ.	Physiology
Leuschner, Miss E. L., M.D., Johns Hopkins, Baltimore, Md.	(Not determined)	Pathology
A. E. Mirsky, Neponsit, L. I.	Cambridge Univ. Eng.	Physiology Biochemistry
H. L. Pelham, M.D., Howard University, Washington, D. C.	Columbia University	Physiology
Bernhard Steinberg, M.D., Boston University School of Medicine	Western Reserve	Pathology
F. W. Stewart, Ph.D., Harvard Medical School, Boston	Boston City Hospital	Pathology
G. J. Strean, M.D., McGill University, Montreal, Canada	Univ. of Iowa	Biochemistry
C. H. Thienes, M.D., University of Oregon, Portland, Oregon	Stanford Univ.	Pharmacology
H. B. VanDyke, Ph.D., M.D., University of Chicago	(Not determined)	Pharmacology

SCIENTIFIC NOTES AND NEWS

THE autumn meeting of the National Academy of Sciences will be held in Pierce Hall, Harvard University, Cambridge, on November 10 and 11, and in the building of the American Academy of Arts and Sciences, 28 Newbury Street, Boston, on Wednesday, November 12. Members of the local reception committee are A. Lawrence Lowell, *honorary chairman;* Theodore Lyman, chairman; Edwin B. Wilson, *secretary;* S. W. Stratton, William C. Wait, G. H. Parker, Thomas Barbour, Hans Zinsser, W. H. Lawrence and A. B. Lamb.

ACCORDING to press dispatches, the Nobel prize for medicine has been awarded to Professor Willem Einthoven, professor of physiology in Leyden University.

DR. HARVEY W. WILEY was the guest at a dinner held in Washington on October 21, in celebration of his eightieth birthday and the fortieth anniversary of

the founding of the Association of Official Agricultural Chemists. R. E. Doolittle, president of the association, presented to Dr. Wiley a bronze medal commemorating his eightieth birthday and the founding of the association.

DR. WILLIAM H. WILMER, of the recently established laboratory of ophthalmology in Washington, has had conferred upon him the decoration of Commander of the Legion of Honor by the French government.

DR. MARTIN H. FISCHER, of the University of Cincinnati, has received from the "Kolloid–Gesellschaft" the Laura R. Leonard prize of the year 1924. The presentation took place at Innsbruck, during the third general meeting of the society. Last year the Leonard prize was given to R. Zsigmondy and Dr. Pauli.

S. G. BLAYLOCK, general manager of the Consolidated Mining and Smelting Company of Canada, has been awarded the McCharles prize by the University of Toronto for solving metallurgical problems involved in the successful treatment of certain complex ores.

THE 1922–1923 research award of the American Congress on Internal Medicine to the University of Pennsylvania School of Medicine, Philadelphia, has been given to Drs. John H. Arnett and Karl Kornbloom for their work on "Vital capacity."

DR. HUBERT SATTLER, formerly professor of ophthalmology at the Universities of Königsberg and Leipzig, celebrated his eightieth birthday on September 9.

THE Rockefeller Institute for Medical Research announces the election of the following officers and members of the board of scientific directors: *Vice-president*, Dr. Theobald Smith, to succeed the late Dr. T. Mitchell Prudden; *secretary*, Dr. Francis Gilman Blake, to succeed the late Dr. L. Emmett Holt, and Dr. John Howland to fill the vacancy in the board created by the death of Dr. Holt.

AT the Harvard University Museum, three emeritus professors, Dr. William M. Davis, Dr. Edward L. Mark and Dr. John E. Wolff, have been replaced on the committee of the museum by Professor Charles Palache, Professor Jay B. Woodworth and Professor Oakes Ames.

The Journal of General Physiology, until recently edited by the late Dr. Jacques Loeb, in association with Professor W. J. V. Osterhout, of Harvard University, will henceforth appear under the joint editorship of Dr. Osterhout, Dr. J. H. Northrop, of the Rockefeller Institute, and Dr. W. J. Crozier, of Rutgers University.

J. A. CARROLL, of Sidney, has been appointed assistant director of the Solar Physics Observatory of the University of Cambridge for five years, in place of E. A. Milne, who has resigned.

DR. R. M. BRONTE, pathologist to the Home Office, England, has been elected the first president of the Harrow Scientific Society.

THE Insular Department of Agriculture, of Porto Rico, has sent Dr. Melville T. Cook, plant pathologist, to St. Kitts, British West Indies, on a special mission in connection with the introduction of cotton seed. Dr. Cook sailed on October 10 and will be away about four weeks.

PROFESSOR GEORGE F. WARREN, of Cornell University, has sailed for Europe as one of four experts selected by the Federal Tariff Commission, at the request of the American dairy interests, to investigate the methods and costs of Danish butter makers.

THREE members of the engineering faculty will be absent from Cornell University during the coming term. Professor Myron A. Lee has leave of absence to do practical work with the Gleason Works in Rochester; Professor Frederick G. Switzer is with the Alabama Power Company and Professor Calvin D. Albert is studying machine design in European manufactories.

MEMBERS of the faculty of Harvard University who have been granted leaves of absence for the whole of this academic year include Dr. A. W. Sellards, assistant professor of tropical medicine; Edward V. Huntington, professor of mechanics, and G. W. Pierce, Rumford professor of physics and director of the Cruft Memorial Laboratory. Ten members of the faculty will be absent for the first half-year including Roland B. Dixon, professor of anthropology; Professor Edward M. East, of the department of biology; Professor W. F. Dearborn, of the school of education, and Professor Albert Sauveur, of the school of engineering. Nine professors will be absent for the second half-year including Lawrence J. Henderson, professor of biological chemistry; Harry E. Clifford, Gordon McKay professor of electrical engineering, and Dr. James B. Conant, assistant professor of chemistry.

PROFESSOR EMILE MONNIN CHAMOT, of Cornell University, has been appointed exchange engineering professor to France for the present academic year.

PROFESSOR O. H. LARSON, head of the department of agricultural economics and farm management at the Agricultural College of Copenhagen, Denmark, is coming to the United States next February, to lecture at Cornell University.

Dr. Charles de la Vallée-Poussin, professor of mathematics at the University of Louvain, will give a course of six lectures at the Massachusetts Institute of Technology from November 1 to 16, as visiting professor to America on the Commission for Belgium Relief.

Dr. Wilfred T. Grenfell, of Labrador, was the guest of honor at a dinner of the Over-seas League, London, on September 26. On October 16, Dr. Grenfell gave a talk before the Royal Society of Medicine on "Medicine in a corner of the empire."

From October 17 to 20, Professor V. H. Blackman, of the Imperial College of Science, South Kensington, London, lectured before the members of the plant science groups of the University of Minnesota on the "Influence of electric currents on growth and on the physiological basis of parasitism," and joined in a number of informal discussions on the campus and in the field.

William Henry Patchell, English engineer, gave a public lecture on October 10 at the Carnegie Institute of Technology in Pittsburgh on "The world power conference at Wembley, England."

Dr. John B. Watson, consulting psychologist for the J. Walter Thompson Co., New York, lectured before the New York Academy of Sciences on October 20 on "Studying the human young."

Dr. S. H. Reynolds, professor of geology at Bristol University, England, addressed the Geology Club at the University of Iowa on "The British lower Carboniferous and the work of Arthur Vaughan."

Professor E. C. C. Baly, of the University of Liverpool, has given two lectures at the University of Illinois on "Reactions, particularly those taking place under the influence of light."

Dr. A. V. Hill, professor of physiology in University College, London, will give two lectures under the auspices of the University of Buffalo on November 8.

Dr. Harvey Fletcher, of the research laboratory of the Western Electric Company, lectured at the University of Iowa on October 20 on "Researches in audition" before the Physics Seminar, and to the public on "The properties of speech, music and noise in their relation to electrical communication."

The physics club of the Bureau of Standards announces a course of sixty lectures by Dr. P. R. Heyl on "The fundamental concepts of physics in the light of modern discovery." These lectures are being given at 4.30 p. m. on Mondays and Thursdays of each week beginning September 29.

Dr. William Botting Hemsley, F.R.S., British botanist and keeper of the herbarium at Kew Gardens, died on October 14, aged eighty years.

Otto Herner, the well-known British analytical chemist, died on September 9, aged seventy-one years.

James Britten, English botanist and for over forty years editor of the *Journal of Botany*, died on October 8 in his seventy-ninth year.

H. G. Smith, for many years assistant curator and economic chemist at the Sydney Technological Museum, known for his work on the essential oils of the Australian flora, died on September 19 at the age of seventy-three years.

Dr. Benjamin Auguste Broca, member of the Academy of Medicine and well-known French surgeon, died on October 3.

The death has recently been reported of Dr. N. M. Knipovich, a well-known Russian scientist, who was drowned in the Black Sea at Yalta. A correspondent writes: Two important expeditions are to his credit: the Murman Expedition of 1900 and the Caspian Expedition of 1904. He also studied and described fishes collected by the Russian Expedition to Spitzbergen. His works were published in the reports of the said expeditions (a series of many separate volumes, Russian with German and English résumés) in *Petermann's Geographische Mittheilungen*, "Annals Hydrologie, Marit. Meteorolog" and "Annals Mus. Zool. Acad. Sciences," Petersburg. He has been a representative of Russia at the "Conseil Internationale pour l'Exploration des Mers," and has for a long time been one of the curators of the Zoological Museum of Petrograd and lately professor of zoology at Petrograd Psycho-Neurological Institute. His special interests, however, were connected mostly with general hydro-biological questions (distribution of marine animals in connection with temperature, salinity of water, etc.) and he was considered for Russia —as Dr. Hjort for Norway—the most eminent explorer of marine life of Russian waters.

Allotments for the use of the American Association table at the Naples Zoological Station have been made to Dr. Otto Glaser, of Amherst College, for the period from February 15 to April 15, 1925; and to Dr. A. R. Moore, of Rutgers College, for the period from April 15 to June 30, 1925. As has been noted in these pages, the Naples Station has been reorganized, under the directorship of Dr. Reinhard Dohrn, son of the original director. It aims to maintain its enviable reputation of pre-war years. Exceptional facilities for biological research are available for workers with plants as well as for workers with animals. Men of science wishing to work at the Naples Station should correspond with the director. Those wishing to have the privileges of the American Association table should inform the permanent secretary of the association, at the Washington office of the organization, in the Smithsonian Institution Building.

THE section of education of the American Association for the Advancement of Science meeting at Washington, D. C., from December 29 to January 3, has arranged the following program: Special applications of scientific methods to educational problems: Freeman, Courtis, Haggerty, Rugg and others; Scientific advancement in school administration: Strayer, Fowlfes, Hines, Ballou, Cubberley; The pre-school child: Woolley, Baldwin, Dearborn, Fernald, Gesell; Character education: Starbuck, McGrath, Neuman, Trow and others; Experimental education: Uhl, Henman, Barr, Buswell, Myers, Persing, Scott, Baker and others. The address of the retiring vice-president, Dr. Henry Holmes, is on "The new social order as seen from the standpoint of education."

THE fourteenth annual meeting of the American College of Surgeons was held in New York from October 19 to 25, under the presidency of Dr. Charles Mayo, of Rochester, Minn. Among the foreign medical men present were: Dr. N. D. Royle and Dr. Ralph Worrall, of Sydney, Australia; Dr. John I. Hunter, lecturer on anatomy at the University of Sydney; Sir Henry Lindo Ferguson, of New Zealand; Professor James Herman, of Stockholm; Dr. Albert James Walton, of London; Dr. H. B. Devine and Dr. James Sands Elliot, of Wellington, New Zealand; Dr. Robert Hamilton Russell, of Melbourne, and Dr. Carrick Hey Robertson, also of New Zealand. Officers for next year were elected as follows: Dr. Rudolph Matas, of New Orleans, *President;* Dr. Eugene Hillhouse Pool, of New York, *Vice-president,* and Dr. John Sinclair McEachern, of Calgary, *Second Vice-president.*

A SERIES of talks are being broadcasted by the Smithsonian Institution from Station WRC, Washington, at 8 P. M. as follows: On October 22, Dr. Frederick V. Coville, of the Department of Agriculture, spoke on "Curious plants." On November 6, Lieutenant Commander George E. Brant will speak on "What the ocean means to us," and on November 13, Dr. J. Walter Fewkes, chief of the Bureau of American Ethnology, Smithsonian Institution, will speak on "Indian cliff houses."

THE National Social Hygiene Conference for 1924 will take place in Cincinnati, from November 19 to 22, headquarters being the Hotel Gibson. This conference will mark the tenth anniversary of the founding of the American Social Hygiene Association, and it will be held under the joint auspices of the national association and the Cincinnati Social Hygiene Society.

THE New York Electrical Society held its 422nd meeting in the auditorium, Engineering Societies Building, New York, on October 23. M. Luckiesh, director of the Lighting Research Laboratory, National Lamp Works, gave a talk on "Light and work."

THE first meeting of the governor's committee to investigate conditions pertaining to medical practice in the rural districts of New York was called by the temporary chairman, Professor Dwight Sanderson, of Cornell University, on February 1, at the office of the State Department of Health. Those present were Professor Sanderson; Dr. Orrin Wightman, president of the State Medical Society; Mrs. Grace A. Powell, president of the New York State Federation of Home Bureaus; Dr. Grant C. Madill, former president of the State Medical Society; Dr. Stover, of Amsterdam; State Senator Byrne, of Albany, and Dr. Nicoll, state commissioner of health. The committee elected Professor Sanderson permanent chairman, and, after considerable discussion, resolved to study ways and means by which an intensive survey could be made of some rural county, in order to determine definitely the adequacy of medical service especially in the more remote rural sections. The members of the committee were unanimous in their belief that this work should be gone into with an open mind and without regard to the consideration of any remedies which might later be agreed upon as the result of the survey.

A GENERAL conference on the Fusarium problem was held during June, July and part of August at the University of Wisconsin, which developed from studies carried on by the United Fruit Company on the wilt disease of bananas in Central America and was held in cooperation with the Bureau of Plant Industry, United States Department of Agriculture. Those present at the conference were Dr. H. W. Wollenweber, pathologist, Biologische Reichsanstalt für Land und Forstwirtschaft, Germany, and Dr. O. A. Reinking, pathologist, United Fruit Company, both representing the United Fruit Company, and Dr. C. D. Sherbakoff, pathologist, Agricultural Experiment Station, University of Tennessee; Miss Helen Johann, assistant pathologist, cereal investigations, and Mrs. Alice Bailey, junior pathologist, office of cotton, truck and forage crop disease investigations, representing the Bureau of Plant Industry, United States Department of Agriculture. The work of the conference covered, in so far as possible, the study, comparison and identification of specimens and cultures of fungi at present available. The studies were made on species from all sections of the sub-genus Fusarium, including important border-line strains, thereby making it possible to arrive at a uniform taxonomy of the group. Pure cultures and dried specimens of each of the species studied and identified will be placed in the office of pathological collections, Bureau of Plant Industry, United States Department of Agriculture.

UNDER authority of the Research Committee of the Archeological Society of Washington, Dr. Mitchell Carroll recently examined with Professor George Grant MacCurdy the prehistoric cave and rock-shelter known as Castel Merle in the commune of Sergeac, 30 minutes from Les Eyzies, considered by Dr. Hrdlička and other authorities as perhaps of equal promise with the now famous prehistoric sites of the region, and concluded a ten-year lease from the owner, M. Castanet, with sole privilege of excavation and control of the finds. This was made possible through the generosity of Colonel William Eric Fowler, one of the trustees of the society. The society entered upon an agreement with the American School of Prehistoric Research to conduct the excavations which began at once in charge of Professor MacCurdy, who has already announced the discovery of numerous prehistoric flint implements in addition to faunal remains. Half the archeological specimens found on the site are to be deposited with the U. S. National Museum as the property of the Archeological Society of Washington.

A CORRESPONDENT writes: "One of the most interesting recent acquisitions by the Museum of the California Academy of Sciences is a magnificent specimen of the East African gorilla. The specimen is an adult male measuring six feet in height when standing erect; the chest measures 63 inches, the span of arms 91 inches and the weight was 480 pounds. These figures show that this specimen is one of the largest gorillas in any museum in the world. It was shot in the Birunga Mountains, north of Lake Kivu, in the eastern part of the Belgian Congo. It was artistically mounted by an expert taxidermist in London, from whom it was purchased for the academy by Mr. A. Kingsley Macomber, well-known clubman and capitalist of Burlingame and patron of the California Academy of Sciences."

PROVISION is made in the will of Andrew W. Preston, late president of the United Fruit Company, that in the event of the death of all heirs the estate shall be used "for advancing the science of chemistry in the United States." The estate is estimated to exceed $6,000,000.

THE Deseret Museum of Salt Lake City, a general geological and biological collection containing one of the largest and most complete mineralogical collections in the West, was recently presented to the Brigham Young University, of Provo, Utah.

FORDHAM UNIVERSITY dedicated on October 24 its recently completed seismic station to be one of the few in the world devoted exclusively to the recording of earthquake phenomena. The building is the gift of William J. Spain, of New York, in memory of his son, William J. Spain, Jr., a member of the class of 1924 at Fordham.

BY unanimous vote the administrative board of the American Engineers Council has agreed to insist on abolition of the Department of the Interior of the Federal Government to be replaced by a Department of Public Works. The Department of the Interior was held to be archaic, and the motion, as put by L. P. Alford, of New York, and formally adopted, called for an aggressive course in support of the new plan.

AUTHORITY for the transfer of approximately 14,000 acres of public land in the Salt River Mountains of Arizona to Phoenix for public park purposes has been granted by the Interior Department. The sale for $1.25 an acre was authorized by the Congress. The land makes available recreational facilities for the entire Salt River Valley population of about 100,000, including Phoenix.

BY far the most comprehensive and vigorous enforcement of the Alaska fishery laws and regulations ever undertaken has been in progress this season under the supervision of the United States Bureau of Fisheries. In southeastern Alaska alone approximately 75 special stream guards have been on duty. Six patrol vessels have been engaged and there has also been the regular force of employees. In other sections of Alaska this character of work has been expanded over that of former seasons. Various cases, including trap and vessel seizures, have been presented for court action. This is the first time that such seizures have been made, authority being derived from the recent Alaska fisheries act of June 6, 1924. Commissioner O'Malley has been in southeastern and central Alaska during most of the current fishing season giving personal supervision to salmon-protection activities. The results will be highly beneficial in reestablishing and maintaining this very valuable natural resource.

UNIVERSITY AND EDUCATIONAL NOTES

THE movement, started last May by the alumni of St. Louis University, to raise $1,000,000 for a new medical college, has thus far brought a total of $410,000 in pledges, according to Dr. Hanau W. Loeb, dean of the school of medicine.

AT the University of Oklahoma two new structures, the medical and engineering buildings, are nearing completion. These buildings are being constructed under the appropriation of $100,000 for each, made by the last state legislature.

THE will of the late Charles L. Hutchinson, of Chicago, provides a bequest of $30,000 to Harvard University for the work of the Arnold Arboretum.

COLUMBIA UNIVERSITY has received a gift of $15,000 from the Borden Company to be used for research in the field of food chemistry and nutrition, and $6,000 from an anonymous donor for the laboratory of surgical research.

WESTMINSTER Hospital Medical School, London, has been offered by A. J. H. Carlill £20,000 towards the establishment of a pathological unit as a memorial to his father.

THE Jefferson Medical College has created a department of bronchoscopy and esophagoscopy. Dr. Chevalier Jackson, professor of laryngology in the college, has been elected to the professorship of the new department. Dr. Fielding O. Lewis has been elected to fill the chair vacated by Dr. Jackson.

DR. GEORGE A. TALBERT, associate professor of physiology at the University of Nebraska College of Medicine, has been appointed professor of physiology at the University of North Dakota School of Medicine.

DR. D. S. MORSE, of Cornell University, has been appointed assistant professor of mathematics at Union College.

DR. HARRY H. KNIGHT, assistant professor of entomology and curator of the insect collection at the Farm School of the University of Minnesota, has resigned to accept a similar position at the Iowa State College.

EDUARDO DIAZ LUQUE was recently appointed professor of physics at the Universidad Nacional in Mexico City; he is also doing work for the Mexican Light and Power Company.

PROFESSOR HENRY BRIGGS, who has been for several years professor of mining engineering in the Heriot-Watt College, Edinburgh, has been appointed to the newly established chair of mining in the University of Edinburgh.

DR. HANS V. HABERER, of the University of Innsbruck, has been appointed professor of surgery at the University of Graz, to take the place of Professor v. Hacker.

DISCUSSION AND CORRESPONDENCE

ALKALINE REACTION OF THE COTTON PLANT

IN an article which has recently appeared under the above title (SCIENCE, September 19, 1924, page 268), Mr. J. E. Mills has referred to some observations published about a year ago by Mr. C. M. Smith regarding the alkaline reaction of the dew of the cotton plant (*J. Agric. Research*, 1923, *26*, 192). The subject was incidentally considered by Mr. Smith in connection with an investigation of "arsenical injury to plants," and from an examination made by him of dew collected from the plants, he was led to conclude that its alkalinity was to be attributed to the presence of the bicarbonates of calcium and magnesium. It was also observed by him that "the dew gave a reaction alkaline even to phenolphthalein," which he stated would indicate the presence of soluble hydroxide or salts of very weak acids. Mr. Mills has now noted (*loc. cit.*) that it would hardly seem possible that the alkalinity of the dew can be attributed to these compounds.

In collaboration with the Bureau of Entomology of the U. S. Department of Agriculture an investigation was undertaken by the undersigned for the purpose of determining the volatile constituents of the cotton plant and of ascertaining their attraction for the boll-weevil. This work was begun in the summer of 1923 and has continued to engage our attention to the present time. Although the complete results of this investigation will be published in due course in a scientific periodical, in view of the above-mentioned article by Mr. J. E. Mills and also the statements relating to the subject from time to time in the daily press it seems desirable that we should now place on record some of our observations.

The chemistry of the cotton plant is a very complex subject, and although much progress has been made in our investigation of it, considerable time will still be required for its complete elucidation. We now particularly wish to state that we believe the alkalinity of the dew of the cotton plant to be attributable, at least in part, to the presence of ammonia and trimethylamine, since we have determined the presence of these substances in it and have also obtained the same substances in very much larger amounts from the products of distillation of the cotton plant with steam. Both ammonia and trimethylamine are evidently emanations from the plant, and it has already been ascertained that the trimethylamine possesses a particular attraction for the boll-weevil. An account of the numerous other substances that have been isolated from the cotton plant and completely identified must be reserved for a future publication.

FREDERICK B. POWER,
VICTOR K. CHESNUT

BUREAU OF CHEMISTRY,
DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

RADIOACTIVITY OF RIPE TOMATOES

IN cooperation with the Bureau of Standards a project for experimental study was outlined in the

summer of 1923, the object being to determine whether or not any radioactive substance occurred in food and if so its significance. Owing to unforeseen circumstances, the experimental work could not be begun at that time. In June of the present year, however, a beginning was made, the food chosen being ripe tomatoes. These were washed in distilled water and then pulped by passing the fruit through a meat grinder of household size. The pulped fruit and juice, 900 cc altogether, was tested for radioactive substance in accordance with the procedure followed at the Bureau of Standards of the United States Department of Commerce, the determinations being made by W. H. Wadleigh, of that bureau. The glass flask containing the pulp and all the other equipment used was taken from stock which had not been exposed to radioactivity. The experimental conditions were such as to prevent the concentration of the pulped fruit and juice during the experiment.

The results obtained are reported in the following table in comparison with Washington city water which was used as a check, its radioactivity being known:

Occurrence of Radioactive Substances in Ripe Tomatoes

		Milimicrograms per liter	
1924	Washington city water		
June 11	for comparison	1.00	
June 17	Ripe tomato pulp and juice	3.28	
June 24	do	4.20	
July 2	do	0.98	result considered unreliable
July 10	do	1.45	
July 15	do	1.14	

After the first determination for radioactivity, the tomatoes were set aside and again tested at the end of a week. This procedure was continued, five tests in all being made with the original material.

The radioactivity noted, though relatively small, was pronounced, being more than three times as great as that of city water. It is also apparent that the amount diminished as time passed.

The topics which suggest themselves for consideration in continuing the work are numerous. One of primary importance is to determine whether or not the radio-active substance is carried into the fruit by ground water taken up by the growing plant or whether it had another origin. Others have to do with the relationship, if any, between such phenomena and nutrition problems now receiving attention.

C. F. Langworthy

Washington, D. C.

THE METRIC SYSTEM

In Science for September 5 there is a letter on the metric system which gives an incorrect impression as to the position of the engineering profession on this question.

The engineer necessarily uses the unit of measure that is the legal standard in the country where he is working, but it does not make any difference whether the unit used is a foot or a meter. The essential thing is that it shall be a *decimal* system, and the engineers of the world are now using a decimal system exclusively for all measurements and calculations. The unit of measure in this country is the foot, and all measurements are made in feet and decimal parts of a foot. The surveyor's chain or steel tape is 100 feet long, graduated in feet and tenths and hundredths. The leveling rod is graduated in tenths and hundredths with a vernier reading in thousandths of a foot. All measurements of every kind are made in these decimal divisions of the foot and all calculations for steel-work, track-work and earth-work, for it would be impossible to apply trigonometry to measurements expressed in feet and inches.

After the calculations are completed the engineer has to convert his decimal fractions into inches and sixteenths for the steel worker and into cubic yards for the grading contractor. Of course all mathematical handbooks for engineers contain tables for converting decimal parts of a foot into inches and sixty fourths, and all railway engineers learn the "twenty-seven times" multiplication table so that they can divide by twenty-seven as easily as most people can divide by twelve, but if manufacturers would use a decimal system also it would save the engineer a great deal of unnecessary trouble and many mistakes, for every translation from one system to the other introduces one more possibility of error.

There is no doubt that a duodecimal system would be more convenient sometimes if our system of numbers were also duodecimal, but the important thing is that our system of measures should agree with our system of numbers.

Kenneth Hartley

Cheyenne Mountain High School,
Colorado Springs, Colorado

The letter by Mr. John Satterly regarding the use of metric weights and measures which appeared in the September 5th issue of Science is of special interest. From visits to Canada, east and west, I can state that his attitude is very unusual. The work of Dr. J. C. McLennan, of Toronto University, is important in this connection. He writes:

In the early part of 1906, at the request of the Honorable L. B. Brodeur, minister of inland revenue of the Dominion Government of Canada, I agreed to deliver

a number of lectures on the use of metric weights and measures.

Through the cooperation of the department mentioned, a schedule of the lectures was arranged and it was made known in various centers throughout Canada that my services in connection with the metric campaign would be available on certain dates for the various local societies interested in this subject.

In carrying out this rather strenuous schedule, lectures were given in Montreal, Ottawa, Toronto, Winnipeg, Regina, Vancouver and in over thirty other Canadian cities. In some places the idea of the simple metric system corresponding to decimal currency was then new to many people. Our meetings were well attended; in some cases as many as six hundred people being present. At the close of each address all present were invited to take part in the discussion of the subject. The pros and cons were propounded with the utmost frankness and in some cases with considerable vigor. Never during this lecture tour or at any other time have I heard, in so far as I can judge, a really valid argument against the general use of metric weights and measures. On the other hand the many valid reasons for their use increase as time passes.

It is highly desirable that this preliminary educational work, conducted entirely at the expense of our government, should be effectively followed up. It is chiefly for the purpose of encouraging others to do their part in securing for Canada the advantages of the use of the metric system that on April 28, 1922, I accepted the chairmanship of the Toronto Section of the Metric Association. At that time Mr. W. P. Dobson, of the Hydro-Electric Power Commission, was elected secretary, and Mr. L. Burpee, of the Canadian General Electric Company, Ltd., was elected treasurer. Our section is composed of volunteer workers who desire to see the metric campaign progress as it should. We believe that everybody can do something to help. We hope that a great many people will let Mr. Dobson know that they will help the metric movement in their own industry or line of work.

The Metric Association has a local section and a good group of members in Toronto. In the French-speaking portions of Canada the public opinion in favor of the metric system is almost unanimous.

HOWARD RICHARDS

METRIC ASSOCIATION,
NEW YORK, N. Y.

QUOTATIONS

SCIENTIFIC RESEARCH

THE patient technique of laboratory research does not seek the limelight of sensational discovery. For this reason the public mind does not grasp completely the significance of the work carried on by hundreds of students, up and down the country, whose investigations are bringing greater worth and purpose to the conditions of national life. The Report of the Committee of the Privy Council for Scientific and Industrial Research for the year 1923–24 serves to remind us of the ever-increasing dependence of health, commerce and industry on the adequate opportunities afforded for scientific inquiry and accomplishment. The problem is, however, less a financial than an educational one. Money for research is there—over half a million was spent during 1923–24—but often the speed at which work can be carried out is limited—as in the case of the Fuel Research Board—"by the number of competent and trained workers available." It is to the university that we must look to give us the trained student, patient though adventurous, imaginative though cautious, cooperating without self-seeking to increase the sum of human knowledge. We have to ensure, also, that no alert and creative mind is barred from that training through lack of means to rise through the secondary school to the university. There is still too much reason to fear that reserves of ability are untapped owing to the failure of certain local education authorities to make careful provision for the poorer scholars. Last year 291 grants were made by the council to research workers and students in training, of which 244 were allowances enabling them to take advantage of facilities for training in research afforded by various universities. The grants made during the academic year 1923–24 amounted to £41,000 as compared with £49,000 during 1922–23. The transfer to university and college authorities of the responsibility for recommending rates of allowance in accordance with the needs of individual students has led to more generous help from local funds and greater local interest in these activities. Nevertheless, the powers of local authorities under section 74 of the Education Act, 1921, are not so fully utilized as they might be.

There are, however, other considerations beyond the financial which need to be taken into account in the training of students for research. Sir William McCormick, the administrative chairman of the Advisory Council, warns against too easy specialization. "Experience has taught us," he says, "to attach great importance to the student's school history, and our conviction grows that in the last two years of school life science must not be allowed to absorb the whole of the students' attention, to the exclusion of the humanities and to the detriment of his general education"; and Sir William urges further that "at a later stage, when the student has graduated and is serving his apprenticeship to research, we should like to see him encouraged to devote attention as part of his training to the historical and cultural aspects of the subject in which he is specializing." Inability to interpret contemporary social phenomena by the light of the past has been one of the causes which have often prevented expansion of method and the acceptance of

new ideas by leaders of industry. The war destroyed much of the crippling conservatism which had hitherto hampered development. The outcome is to be seen in more scientific organization and production in factory and workshop. Probably no movement has been of greater value to industry than the setting up of research associations in 1918, 1919 and 1920 under the government's scheme for industrial research and the consequent growth of cooperation and team work in dealing with problems common to the methods and processes of the various trades. The report shows that many of these problems are incapable of solution by one branch of science alone, and consequently it is essential that there should be increasing cooperation between chemists and physicists, biologists and engineers. An interesting instance of cooperation with medical research is seen in the financial help given to the Medical Research Council, accompanied by expert assistance from the Engineering Research Board, to enable the council to investigate problems of machine design in relation to the comfort and efficiency of the operator. Employers are only now beginning to understand how greatly industrial contentment, efficiency and output can be increased by comfort in manipulation and adequate light and ventilation in the factory.

There is need also to educate public opinion in regard to the value of research in the domain of national health, and the work of the Fuel Research Board in this direction should receive more general recognition. The Gas Regulation Act of 1920, which was based on the work of the board, has already led to substantial savings. The physical and chemical survey of the national coal resources, the research in carbonization and in by-products, the possible modification of the blast furnace are all likely to have important bearing on the prevention of waste and the diminution of the smoke evil. Public opinion, however, must press for proper fuel control in industrial works; "without it," says the report, "the advantages of better fuel which research may provide would be largely nugatory."—*Educational Supplement of the London Times.*

SCIENTIFIC BOOKS

The Physiology of Photosynthesis. By SIR JAGADIS CHUNDER BOSE. Longmans, Green and Co., New York, 1924; VII—287 pp., with 60 illustrations.

THE work under review comprises twenty-eight short chapters on about as many separate problems of the phenomenon of photosynthesis. The author confines himself largely to a description of apparatus and experiments of his own design and the results he has obtained therewith. The experiments were carried out with the water plant, *Hydrilla verticilla,* and the evolution of oxygen from the plant during illumination was taken as a measure of the rate of photosynthesis. As has been known for a long time, the gas which is emitted from an illuminated plant is not composed of pure oxygen but contains varying amounts of nitrogen and carbon dioxide. In order to avoid this source of error in the determination of photosynthetic activity by the volume of oxygen emitted, the author, in one of the methods described, removes the nitrogen from the water and the plant by placing these under a vacuum at the beginning of the experiment. It is stated that under these conditions pure oxygen is evolved in the light. Another familiar error in the bubble-counting method is due to the variation in the volume of the bubbles. This error the author has endeavored to remove by the use of a device which collects a definite volume of gas; a slight increase in the pressure of the gas causes its release, which is recorded on a revolving drum. By means of this apparatus, which was also elaborated into an automatic recorder of photosynthesis, a variety of factors which influence the rate of photosynthesis were studied.

In the results obtained on the relation between light intensity and photosynthetic activity no new contributions are made. Thus it is concluded (p. 48) that "Taking all factors into account, we find that *the activity of photosynthesis is proportional to the quantity of incident light.*" It is most unfortunate that absolutely no regard should have been taken of the mass of valuable information which has accumulated during the past twenty-five years on this and many other phases of the photosynthesis problem. In the arrangement of the experiments and in the interpretation of the results obtained the facts which led to the formulation of the theory of limiting factors are entirely disregarded, nor is there any consideration of the conclusions of other recent workers in the field, such as Harder and Lubimenko. The result of this general neglect in endeavoring to coordinate the observations recorded with the body of existing knowledge in photosynthesis is a most unsatisfactory one. Many of the phases of the photosynthesis problems are touched upon; none of them have been subjected to a thorough investigation. There are many interesting observations recorded, but their bearing is not certain because either they are purely unconnected or incomplete.

Interesting are the results of traces of iodine, formaldehyde and nitric acid on the photosynthetic activity. It was found that minute traces of these substances accelerate the activity enormously. Less fortunate are the author's conceptions of the "period of photosynthetic induction" and "photic stress"; the phenomena observed have been fully discussed some

years ago by Kniep and others. Chapters XIII and XIV describe an ingenious self-recording radiograph and a portable photometer which make use of the selenium cell as the light sensitive element.

The question of the influence of CO_2-concentration on the rate of photosynthesis has received much attention during the past ten years. It is of particular importance on account of its bearing on Blackman's theory of limiting factors. That the curve of photosynthetic activity with varying concentration of CO_2 and constant light intensity exhibits no sharp turn but is rather approximately a logarithmic one was indicated by the results of Boysen-Jensen (1917), Willstaetter (1918), Warburg (1919), Harder (1921). Bose also concludes: "My results show that the top of the photosynthetic curve rounds off gradually after the turning-point, and is never abruptly horizontal . . ." Only one light intensity was used; had similar experiments been carried out with a variety of light intensities they would have constituted a valuable test of Harder's conception of limiting factors. An attempt is also made to determine the oxygen-carbohydrate factor, a ratio between the weight of oxygen emitted and that of carbohydrate elaborated during photosynthesis. On the basis of the chemical equation commonly assumed to represent the photosynthetic reaction: $6CO_2 + 6H_2O = C_6H_{12}O_6 + 6O_2$ this ratio would be $\frac{C_6H_{12}O_6}{6O_2} = \frac{180}{192} = 0.9375$. The author measured the gas emitted and determined the increase in weight during a definite period of photosynthetic activity. He comes to the conclusion that the oxygen-carbohydrate factor is 0.8906 or 5 per cent. less than the theoretical value. This is called the normal value. In specimens which previously had been exposed to strong light the factor was 0.91, in those exposed to semi-darkness 0.87. The explanation for these discrepancies is sought in the possibility that other carbohydrates besides those having a molecular weight of 180 are elaborated. Apparently the fact, clearly established by Kniep, was lost sight of: that the gas evolved in photosynthesis is not pure oxygen, the composition varying with the rate of gas evolution. Analyses of the gas were not made nor were precautions taken to avoid admixture of other gases. The low value of the $\frac{\text{carbohydrate}}{\text{oxygen}}$ ratio is in all probability due to the fact that the gas collected was not pure oxygen. Furthermore, under conditions of high light intensity (more active photosynthesis) the proportion of oxygen in the emitted gas is high, which accounts for the relatively high value of the carbohydrate-oxygen factor found; while under low light intensity the proportion of oxygen is low, which would result in a correspondingly low factor by the methods employed.

It is undoubtedly true that physiology is more than applied physics and chemistry; yet in endeavoring to ascribe to every effect a discernible cause in a quantitative as well as qualitative sense, it is doubtful whether physiology can find, for the present, more valuable methods and conceptions than are offered by physics and chemistry. This is especially true in the subject of photosynthesis, for which the exact sciences have made available most valuable information during the past few years, and it is only through the application and elaboration of these conceptions that we can hope for a true physiology of photosynthesis.

H. A. SPOEHR

CARMEL-BY-THE-SEA,
CALIFORNIA

LABORATORY APPARATUS AND METHODS

INSTANTANEOUS PHOTOMICROGRAPHY OF THE SKIN CAPILLARIES IN THE LIVING HUMAN BODY

LOMBARD,[1] in 1911, showed that certain capillaries in the human body could be rendered visible under the microscope by adequate illumination. Dr. Mueller and his pupils have extended the usefulness of this method in clinical medicine. Professor Krogh,[2] of the University of Copenhagen, and his colleagues have made very elaborate studies on the anatomy and physiology of capillary circulation. For several years past, Drs. G. E. Brown[3] and H. Z. Giffin[4] and others, of the Medical Research Laboratories of the Mayo Clinic, have been making extensive quantitative clinical studies of the capillaries, as to sizes and blood circulation, both in normal and disease conditions.

In the microscopic study of the physiology of capillaries, the general method of procedure has been to observe visually by the aid of the microscope the changes taking place and the reactions to various experimental procedures. However, no documentary evidence of these observations by means of photographic records has been, in general, possible and, so far as we know, no such documentary evidence exists in the various studies on the capillaries of the living human body. Krogh[5] and others have suc-

[1] Lombard, *American Journal of Physiology*, Vol. xxix, 335, 1911–12.

[2] Krogh, "The Anatomy and Physiology of the Capillaries," New Haven, 1922.

[3] Brown, *American Annals of Clinical Medicine*, Vol. 1, 69, 1922.

[4] Brown and Giffin, *American Journal of Medical Sciences*, Vol. 166, 489, 1923.

[5] Krogh and Rehberg, *American Journal of Physiology*, Vol. lxviii, 153, 1924.

ceeded in obtaining with considerable difficulty photomicrographic records of the capillaries and the circulation in transparent tissues of *Rana temporaria* "at rates varying from 20 photographs per second downwards." Obviously, methods and procedures which would be applicable to the study of the capillaries in transparent tissues of frogs, in which transmitted light could be used, would be of little or no service in obtaining photomicrographs of the capillaries of the human body in from one tenth to one one-hundredth second. For the results obtained in photomicrographing capillaries at the nail-fold, for example, must be dependent on the amount of light which penetrates into the tissues, the portion thereof which is reflected by the capillaries (that is, the contained blood) and which then, in turn, traverses its way through the tissues to the microscope.

As is well known, but little light is needed to make the capillaries microscopically visible to the eye. The problem from the photographic standpoint, however, is much more difficult, due chiefly to the following: (1) inability to get sufficient illumination returned to the plate or film to enable photomicrographs to be obtained in a fraction of a second; (2) with longer exposures, of the order of a few seconds, the difficulty of preventing mechanical movements of the hand or finger, or again of the apparatus used, and (3) should such movements as have been mentioned be eliminated, the impossibility of prevention of slight rhythmic movements due to the pulsations of the heart.

Certain preliminary experiments demonstrated to our satisfaction the uselessness of endeavoring to overcome the difficulties mentioned in (2) and (3), and that success in instantaneous photomicrography of the capillaries in the tissues at the nail-fold would result only through the use of very intense external illumination, so filtered as to remove heat and certain shorter wavelengths of radiation, and directed at such an angle as to throw the light reflected by the surface of the skin out of the direct path of the light reflected by the capillaries and transmitted to the photographic plate or film. Our procedure has been to use as a source of light a 5 ampere direct current arc-lamp, with which to make preliminary visual observations, and, when photographing, to throw suitable resistances in parallel with the fixed resistance for an instant only, permitting 30 to 50 amperes to flow through the arc-lamp. In this manner, both with and without suitable glass and liquid filters, we have been able to obtain satisfactory photomicrographs varying in magnification from 100 to 10 in from one tenth to one one-hundredth second. The contrast has been excellent, the mechanical and rhythmic movements previously mentioned wholly eliminated, and the possibility of an "at-will" photographic record of capillary changes assured. We have also succeeded in making use of an ordinary kodak film, and in taking a series of photomicrographs as desired, approximating a cinematographic record as closely as would ordinarily be desired or of likely service. Further experiments are being carried out on the construction of simple but suitable apparatus for enabling long series of permanent records of capillaries to be taken and kept for measurement and the tabulation of data.

We are informed that various persons have, at different times, made attempts to obtain instantaneous photomicrographs of the capillaries in the living human body, but, in so far as we know, none of these attempts have been successful. Mr. Earl Irish, working in conjunction with Dr. Brown, of this clinic, succeeded about two years ago in getting two fairly good photomicrographs, but the times of exposure were too long and there were evidences of movement. Through the use of the simple procedure we have outlined, practically every photograph is satisfactory and usable for measurements.

We believe that these photomicrographs which we have been able to obtain during the past few weeks are the first photographic records on skin capillaries in the living human body obtained by methods which permit of photographing at will, under normal conditions—for example, without ballooning through the use of a turniquet, and so forth—with good contrast, in any magnification desired, and in from one tenth to one hundredth second, thus ensuring no movements and therefore giving reliability to the data obtained from the measurements of the capillaries.

A reproduction of an "untouched" print made from an original plate in which the magnification is 100 and the time of exposure one tenth second, is enclosed, but I feel that it can not be reproduced to advantage on the paper used in SCIENCE.

The problem of accurate quantitative determinations of the caliber of the capillary loops is wrapped up very intimately with the problem of capillary permeability. It is hoped that these studies will lend additional assistance to the solution of the problems of clinical medicine.

A more detailed account of these experiments and others now in progress will be made later through the channels of medical literature.

I have to thank my assistants, Mr. A. Porter and Mr. R. Halstead, for their aid.

CHARLES SHEARD

SECTION OF PHYSICS,
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SPECIAL ARTICLES

THE CIRCULATORY SYSTEM OF THE BRINE SHRIMP[1]

THE brine shrimp, *Artemia salina principalis,* has received extensive biological study in the Hopkins Marine Station and the Stanford University under the direction of Professor E. G. Martin. Due to the fact that it lives in sea-salt brines of extreme saturation, it presents numerous problems of peculiar physiological interest. It seems that to date no one has given especial attention to the anatomy and the physiological manifestations of the circulatory organs and tissues of this animal. Artemia lives on unicellular algae and bacteria and its alimentary tract is not clogged with a great deal of opaque material. The tissues themselves are unusually transparent. It is possible to make out the gross and in fact much of the details of the microscope structure by direct inspection of the animal itself under the compound microscope. The following notes are presented for record.

THE ANATOMY OF THE CIRCULATORY SYSTEM

The plan of circulation in Artemia is the open lacunar system, characteristic of crustaceans. However, the anatomical arrangement is much simpler and very much easier of demonstration than in the higher forms, for example, the decapod crustaceans.

The heart: The heart is a simple longitudinal tube, suspended in the body cavity dorsal to the alimentary tract. It is surrounded by open lacunar spaces, being anchored with more or less firmness by the tissue strands from its walls to the alimentary canal and to the body wall.

The heart tube runs the full length of the animal from the caudal segment to the base of the rostrum. It is an exceedingly thin-walled muscular structure. At the extreme posterior end of the heart is a single opening or slit, the caudal ostium. It is guarded by slight enfolding of the lips which operate as valves. The slit of the opening is dorso-ventral, as is that of all the cardiac ostia.

There are bilaterally symmetrical pairs of ostia, from fourteen to fifteen in number, apparently segmental in arrangement, distributed along the sides of the heart tube from the posterior end for two thirds or more of its length. These ostia are guarded by valves as in the case of the terminal or caudal ostium. The walls of the valves are so thin that it requires a medium magnification (x 200–250) to bring them into clearest vision.

There are no ostia along the extreme anterior portion of the cardiac tube. The anterior end of the heart opens freely into sinuses or lacunae at the base of the antennae and eye stalks and adjacent head region. There are no internal cardiac valves.

The lacunar system: There are no blood vessels (Gerstæcker) other than the heart tube, in Artemia. There are certain channels that are well marked and fairly definite. No linings or definite walls of the vascular type were observed. The body cavity and lacunae of the body and appendages are filled with a clear fluid that contains in suspension many nucleated corpuscles. The movements of these corpuscles enables one to follow the outlines of the spaces with remarkable ease. These channels and spaces of the body can be followed out through the appendages—the eye stalks, base of the antennae, limbs, etc. The outlines of the body cavity spaces are much more definite toward the posterior part of the body.

PHYSIOLOGY OF THE CIRCULATION IN ARTEMIA

The body fluid or blood of Artemia is kept in circulation by the interaction of two mechanical factors. First, the pumping of the heart tube and, second, the general body movements, primarily of the appendages.

The contraction of the heart: The straight heart tube contracts rhythmically, with a rapid wave-like movement. The contraction begins at the posterior end and runs in a peristaltic wave toward and over the anterior end. The rhythm at laboratory temperatures and in sea water varies about 125 per minute. The succeeding contraction begins before the preceding one has passed off the tube. The movements of the wafer-thin valves that guard the vertical slits of the pairs of ostia furnish an index of the relative pressures in different parts of the tube and in the adjacent lacunar spaces. This observation is further facilitated by the passing of white corpuscles. Very seldom does one observe corpuscles to move outward through an ostium, or to repass the valves during a peristaltic contraction wave. Occasionally there is a well-marked back and forth movement in the spaces adjacent to the ostia. Even in such instances one could usually observe that the corpuscles had not quite passed the portal of the valve before the peristaltic wave came along.

[1] Professor Ernest G. Martin and Professor Harold Heath, of Stanford University, have made extensive physiological and morphological studies of the west coast Artemia, available in bounteous quantities in Elkhorn slough and adjacent salt beds of the marshes bordering Monterey Bay. This form is a beautiful type for teaching purposes, especially for microscopic demonstration of the open or lacunar plan of circulation. It is remarkably transparent and can be used even under magnifications that reveal cell structure, including muscle striation. It was while preparing material for demonstrating before Dr. Martin's laboratory class in physiology of marine forms that these observations and notes were developed. Since nothing seems available, in the modern literature at least, for the guidance of students of biology these notes are presented. Publication is with Professor Martin's generous consent.

Since there are no valves in the anterior part of the tube and the anterior end is unguarded and freely open into the heart sinuses, it would seem that the forward movement of the blood is the result of differential pressures produced by the passing of peristaltic waves as supported by the valves guarding the ostia. In confirmation of this is the easily observed fact of the pouring in of the blood stream through the ostia during the relaxation stages of the heart tube.

At the wide open anterior end of the cardiac tube the blood flow shows a rhythmic slight backward movement followed by a more pronounced onward rush synchronous with the heart beat. The phenomenon is more clearly observed when accentuated by pressure of the cover slip on an animal mounted in a culture slide.

The blood flow in the body lacunar spaces: The flow in the body cavity and in the appendages is broadly speaking from the cephalic toward the caudal region. But the rate of flow from time to time in particular regions, and to no small extent the direction of flow, varies with the body movements. When the plane of focus is varied between that of the body cavity in the mid-length at the superior surface of the alimentary canal and the slightly deeper plane, blood corpuscles are seen moving along the sides and surface of the gut in a general caudal direction. If a contraction of the digestive tube occurs, then broad fields of corpuscles sweep across the canal surface from one side to the other, now in one direction and now the other.

In the caudal third of the body-cavity well-marked streams of blood are to be observed on each side of the canal that sweep down into the tail lymph spaces and swirl about to enter the lateral as well as the caudal or terminal ostium of the heart. The lateral ostia are clearly marked by entering streams of blood from these two main currents. One can think of these lacunae as pericardial in type, in the sense in which the term is used in the higher crustacean types—crabs, crayfishes, etc.

The blood flow in the appendages: The outward flow of body fluid into the appendages is in more definite channels, and more rapid and constant, especially in the more anterior pairs—the eye stalks, the antennae and the first two or three pairs of legs. In the leg segments, especially in the so-called respiratory plates, the lacunae often form quite definite capillary-like patterns. The blood can be observed to flow out in the larger of these, usually to one side, and back in adjacent and smaller spaces, sometimes on the opposite side of the appendage. However, in the peripheral regions the flow is often reversed, and varies greatly in speed from time to time in particular spaces. Observing different regions at the same time, the variation in rate of flow in symmetrical appendages is a striking fact. This fact seems largely to depend on the mechanical influence of general body movements.

The activity of the heart, the movements of the respiratory appendages and of the alimentary canal all furnish splendid physiological indexes for interpreting the immediate physiological effects of variations in environmental conditions.

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THE REPRODUCTIVE CYCLE OF THE CHARACEAE

A SINGLE tuft of a very interesting species of *Nitella* (as yet undescribed) was found by me several years ago in a pool on the grounds of this university, and the same species has recently been located in a greater quantity elsewhere in this vicinity. Its most striking peculiarity is that the antheridium is divided into longitudinal quadrants only. I had never felt satisfied with my knowledge of this organ and the mode of its development, and its much greater simplicity in this new species led me to undertake its careful study, as well as that of the oogonium.

I had made some substantial progress in this when my work was interrupted for a few years by circumstances that need not be detailed here. I took it up again last summer and have this year devoted my entire time to it for nearly three months. I have now begun upon a comparative study of a member of the same genus in which the antheridium has the classical division into octants. It is my purpose to follow this with a similar study of species of at least two of the other genera that compose the family of the Characeae. I hope to be able in the near future to publish a detailed account of my results. In the meantime I feel that some of those that I have already obtained will be of interest as throwing light upon this peculiarly aberrant group of plants. They refer, of course, to this particular species.

The first of these is the fact that the plant-body, with its very definite structure, is in the diploid phase (the "2x-generation"), differing in that important respect from any of the Green Algae (as far as we know).

The second, and most important, is the location of the reduction divisions in both the oogonium and the antheridium. This takes place in the apical cell, at a very early stage, in the primordium of each organ. This cell, in the oogonium, soon becomes elongated transversely and assumes an ovoid shape in becoming

the oocyte: it rests directly upon a nodal cell, which gives off the five sheath-cells and then divides no farther, becoming the stalk-cell of the oogonium. By the time the tips of the earlier sheath-cells have reached the level of the oocyte the latter divides at its smaller end, which is directed slightly upward: the new cell, which is soon separated by a distinct wall, is the first polar body. Very soon after the nucleus of the oocyte divides again in a direction at right angles to the first division, that is, downward and slightly to one side, and the new cell is separated by a distinct wall; it is the second polar body. The new "mature" ovum soon elongates vertically, its nucleus assuming its characteristic position near the base.

The rapid enlargement of the ovum and the inward pressure of the upper ends of the sheath-cells (which have already begun to form the corona) cause the first polar body to move toward the base: on its way it sooner or later divides to form the two secondary polar bodies. This completes the formation of the three famous "wendungszellen" (which, as will be seen, are *not* formed by three successive divisions of the oocyte).

In the antheridial primordium the apical cell early becomes swollen and elongated. The nucleus then divides in a horizontal plane: and this is immediately followed by a second division in the same plane, but at right angles to the first: both divisions take place before any indication of parting walls are seen, the four resulting "resting" nuclei being located in a horizontal group at equal distances from each other in the cytoplasm of the single enlarged mother-cell. The longitudinal parting walls soon follow, thus completing the formation of the quadrant cells. This is the reduction division; and all that now follows is in the haploid phase (the "x-generation"). The further development of the antheridium shows in this species some interesting features that have not yet been noted, but I will not discuss them here, except to say that in this species the total number of spermatic filaments does not exceed sixteen, two being given off by each of the four capitula, and two from each of the four capitella. This can be clearly seen until the filaments become so long and so much intermingled as to fill the entire cavity and hide the basal cells from sight. No branching of the filaments has been observed.

The counting of the chromosomes is very difficult, owing to their small size and their crowding in the very small mitotic figures. Repeated counts, which have in most cases been independently corroborated by colleagues familiar with such work, give 15 (or 16) for the haploid and 30 (or 32) for the diploid phase.

This preliminary notice has been published for two reasons. The first of these (as has been already indicated) is that it may be of interest and service to those who desire to know more about this unique group of plants. The second is that, for the comparative study that I purpose to make, I am in need of material and of assistance in obtaining it. I am very desirous of obtaining well-fixed material of any dioecious species of *Nitella*. One species of *Chara* I have located in an adjoining county; but I should be glad to have other species. I am particularly desirous to get some good material of *Tolypella*, which I have not yet been able to find, here or elsewhere. I should be more than glad to see and study plants of either of the three remaining genera of the family, but they are very rare. Any one, therefore, who can conveniently help me to obtain well-fixed material of either of the three principal genera of the group will do me a great kindness.

It is now probably too late for securing good material in which the formation of the reproductive structures is still going on, except in the more southern regions of this country. I hope, however, that this request for assistance will be borne in mind next season by some of those living in more northern regions where such material can then be obtained.

A few words regarding its preparation. It is essential that the fixing solution be carried to the place of collection and the plants (or tips of large plants) put into it at once. Any good fixing mixture that penetrates (and therefore kills) quickly will serve. Thorough washing should be at once followed by successive alcohols up to 70 per cent.

The material should then be sent by express at my expense to me at the address given below.

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THE PLASTICITY SYMPOSIUM AT LAFAYETTE COLLEGE

PROGRAM of the Plasticity Symposium held at Lafayette College on October 17, Professor Harry N. Holmes, presiding.

Introduction: EUGENE C. BINGHAM, Lafayette College.

Emulsions: HARRY N. HOLMES, Oberlin College.

The plasticity of single crystals as related to their crystal structure: WHEELER P. DAVEY, General Electric Research Laboratory.

The plasticity of clay: WILDER D. BANCROFT and LEON E. JENKS, Cornell University.

The Ostwald viscometer as a consistometer: WINSLOW H. HERSCHEL, United States Bureau of Standards.

Plasticity in relation to gelatine: S. E. SHEPPARD, Eastman Kodak Company Research Laboratory.